Chem 226/ Dr. Rusay
Fall 2004

Olfaction [Part I: Odor and Molecules]

Taste & Smell (Olfaction)

Cells with taste receptors concentrate in small clusters known as taste buds, which are scattered like small islands on the tongue. There are five basic tastes: *sweet*, *sour*, *bitter*, *salty* and *umami*, which relates to MSG, mono sodium glutamate. However, the sense of smell is far more complex. There are receptors for the sense of smell that can be sensitive to thousands of different organic molecules (odorants). The nose serves as a chemical detector for these odorants much like an analytical laboratory instrument. The perfume industry takes advantage of this as the *Contra Costa Times* article describes.

The vials that you are going to smell contain very dilute solutions of a single volatile compound. Your group will categorize a number of compounds according to their odor. The smell categories for the compounds are: *Fruity, Putrid, Minty, Camphoraceous* or *Other*. You will have a limited time to develop your data once you have been advised to start so budget your time! Your group will be called upon to orally describe the results to the class. In Part II we will determine whether or not a compound's molecular formula can be used to relate to its odor.

Directions

- Sit in groups of 3-4.

- Each individual in the group must serve in one of the following roles. Quickly select your roles. If there are 3 in a group, two roles (b & c) can be combined. The deadline for completion of ***Part I*** is posted on the blackboard. (The time that the form on the back of the page is to be turned in.)

a) **Sample manager**: Obtain sample vials, distribute vials one at a time to the group and keep track of the samples, return the vials after the activity is completed.

b) **Recorder #1 / Spokesperson:** Complete the form on the back of the page**.** Check the one-word descriptions for each vial and for each group member. (Use the following table. More than one box can be checked. Group members' opinions need not be the same). Be prepared to describe the group's results to the class.

c) **Recorder #2 / Spokesperson**: Write down any problems the group is having in describing the vials and/or in agreeing, e.g., an individual could not detect an odor, two people have colds, etc. (Use the following table). Be prepared to describe the group's results to the class.

d) **Facillitator / Timekeeper**: Facilitate group discussion as to which smells are similar and belong in the same category. **Keep track of time and alert the group of the time remaining!** On your form copy the results from Recorder #1 and turn-in before the completion deadline.

Olfaction: Distinguishing Organic Molecules Based on Odor
Part I

Names: _____ Sec._____

#	Fruity	Putrid	Minty	Camphor (Like Vicks)	Other (Describe)
O-1					
O-2					
O-3					
O-4					
O-5					
O-6					
O-7					
O-8					
O-9					
O-10					
O-11					

Comments:

CONTRA COSTA TIMES

Thursday, June 20, 2002

Perfumery school sniffs out talent

The school outside Paris trains potential employees to create the next top scent

By Jasmin Mueller
BLOOMBERG NEWS

PARIS - A whiff of peach permeates a hallway. From around the corner comes a waft of fresh mountain air. And in an office, a man is sniffing a sample of watermelon.

The olfactory diversity is all part of life at Givaudan SA's 52-year-old perfumery school outside Paris. Here, the Swiss flavors and fragrances company trains potential employees to find top-selling scents such as Calvin Klein's Obsession.

To create perfumes, all companies start out with the same ingredients, like rose, jasmine, bergamot and sandalwood. It's up to the imagination of the perfumer to mix those scents in a new way and up to companies to pick out those who can do it best.

"It's like Formula One -- we can all learn to drive, but some have a particular talent, while others just go through the motions," said Jacques Polge, a school graduate and the perfumer who created scents such as Chanel's Coco and Allure.

Each year, school director Bernard Escano interviews about 40 of the most promising students from a pool of some 200 and picks out as many as five applicants. Geneva-based Givaudan spends about 65,870 euros ($62,297) over three years to turn each student into a perfumer.

So far, the investment is paying off. "One out of three creations on the market is the work of a perfumer that passed through Givaudan," Escano said.

Givaudan is also outperforming market leader International Flavors & Fragrances Inc. While shares of its closest rival are little changed, Givaudan has gained 13 percent since becoming independent from Roche Holding AG in June 2000.

"The perfumery school is the little extra that sets the company apart," said Escano, sitting in his office in front of an eight-inch-high bronze sculpture of a nose.

Competitors in the $11 billion industry see Givaudan's school as an unnecessary expense. Chanel and the Quest International unit of Imperial Chemical Industries Plc look for new hires at the High Institute of Perfume, Cosmetic and Food Flavoring, also known as Isipca, a French establishment where about 36 students a year get a perfumery degree.

"Isipca is the only real school" to train perfumers, said Jerome Jallat, marketing development director at Quest.

Givaudan students say they don't need a degree because the school's prestige will be enough to attract rivals' attention.

"There are a number of students that have been hired straight out of school," said Guillaume Flavigny, 25. "They come and buy us out, a bit like football players."

Students spend much of their time assembling samples and trying to distinguish odors with test tubes and bits of dipping paper. They practice their craft by re-creating classic fragrances such as Chanel No. 5.

The students learn to make fine perfumes -- those one wears -- and functional ones, which are used in shampoos and soaps. And they learn speed.

"We no longer have three months, let alone a year, to create the eighth wonder of the world," said Escano, who has run the school since 1998 and is himself a graduate. "Nowadays, you have to create it in a month, or even two weeks."

All told, a perfumer will need about five years to memorize as many as 2,000 individual compounds. And that's about how long it takes Givaudan to see a return on its investment, Escano said.

Givaudan's school is set in an industrialized section of the Paris suburb of Argenteuil, in a three-story brick building Givaudan designed. It moved from the southern perfume town of Grasse, known for its rose and lavender fields, in 1998 to get closer to "reality," Escano said. Still, students go back every year to sample the smells of Grasse.

"You constantly need a new source of inspiration," said student Sonia Constant, 23. Constant, who's one of seven men and women learning to make fragrances at the school now, says she sometimes finds hers in a movie theater or from a memory.

"It's great to be able to create what you've imagined," said Axelle Beernaert, 25. "I take my inspiration from many different sources including nature, cooking, a dream or an emotion."

Today's school has its roots in two fragrance and flavor houses: Roure, founded in 1820 by Claude Roure in Grasse, and Givaudan, created in 1895 by brothers Leon and Xavier Givaudan in Vernier, Switzerland. Roche bought Roure and Givaudan and combined them in 1991.

Thanks in part to ties the school has helped create between the company and fragrance makers, the rate of turnover at Givaudan has declined to about 10 percent, Escano estimates.

And loyalty can be crucial. A successful perfume returns an operating margin -- operating profit as a percentage of sales -- of 25 percent, according to analyst estimates. "The perfumer is the keystone of our industry," Escano said.

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Olfaction [Part II: Odors and Molecular Formulas]

Most of the flavors and fragrances that you are familiar with such as some of those used in Part I come from natural sources. It has long been an interest of science to determine what is smell and odor. A molecular theory of and a model for smell has evolved. For background references see:

http://ep.llnl.gov/msds/orgchem/Chem226/smell-links.html

Your group is now to consider the question: *Is there a correlation between odor and molecular formula?* The molecular identity of an organic compound is determined from its physical properties and data from various chemical and instrumental methods of analysis. A common method that is still used today is combustion analysis, which produces weight percent data for a pure sample that is used to calculate the compound's molecular formula. I have calculated the molecular formula for certain compounds. Your group is to complete the following table from the data provided. Each member should individually do at least one calculation. If you don't recall the calculations consult a General Chemistry textbook for an example. There are a few in the lab for your use. After obtaining all of the formulas, complete the accompanying form, compare the molecular formulas to the accepted categories assigned to the samples from **Part I**, which are provided. Under comments, report whether or not there is any correlation between a certain smell and a general type of molecular formula. Turn in the form before leaving the lab. Include the names of those group members who participated. Keep a separate copy for your group's reference.

Individually, answer the questions that follow the group form. They are to be turned in at the start of the next lab period.

Combustion data for O-7:

A sample of **O-7** weighing 0.3339 g was burned producing 0.8329 g of CO_2 and 0.4120 g of water. The mass of the molecule was determined from the molecular ion in its mass spectrogram. It is 88.15 amu which is equivalent to 88.15 g / mol. Calculate the molecular formula and fill in the following table.

Names: _____ Sec._____

Olfaction: Odor and Molecular Formulas
Part II

#	Weight Percent MM (Molar Mass)	Molecular Formula	Smell Type (from Part I)
O-1		$C_8H_8O_3$	Minty
O-2		$C_6H_{15}N$	Putrid
O-3		$C_7H_{14}O_2$	Fruity
O-4	C 64.82%; H 13.60%; O 21.58% MM = 74.12 g / mol		Camphor
O-5	C 62.04%; H 10.41%; O 27.55% MM = 116.16 g / mol		Fruity
O-6		$C_{10}H_{14}O$	Minty
O-7	See combustion data on instruction page.		Camphor
O-8	C 54.50%; H 13.72%; N 31.78% MM = 88.15 g / mol		Putrid
O-9		$C_4H_8O_2$	Rancid/ Complex
O-10		$C_6H_{10}S_2$	Garlic/ Complex
O-11	C 79.96%; H 9.39%; O 10.65% MM = 150.22 g / mol		Caraway/ Complex

Name _____ Sec. _____

Olfaction [Part II: Odor and Molecular Formulas]

1. Show your calculation for the molecular formula of O-7.

2. Sketch your interpretation of the process involved in smell on a molecular level, where a person detects a molecule of compound ***X*** which has a shape that is a *sphere*. Your sketch should show how molecule ***X*** interacts with the cells and tissue in your nose to ultimately produce a signal that is transduced (transmitted) to your brain resulting in a memory of that molecular-odor stimulus. Label the drawing.
   Consult: *http://ep.llnl.gov/msds/orgchem/Chem226/smell-links.html*

3. Provide a second drawing on a molecular level that can explain odor selectivity and a short sentence or two describing your theory accounting for different smells; i.e., why there are different smells for different molecules. Use simple geometrical shapes to illustrate your model.